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Art. I.—THE BRAIN NOT THE SOLE ORGAN OF THE MIND.*

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The Inaugural Address Delivered on Assuming the Presidency of the Society, May 3d, 1875.

GENTLEMEN: Again I have to thank you for conferring upon me the honorable office of President. In the brief review of the progress of the Society which, as the outgoing President, it was my duty to make, I have touched upon those points in our affairs which appeared specially worthy of attention, and it now only remains to me to deliver the inaugural address on assuming for the second time the office to which, by your partiality, I have been elected.

In choosing the subject, "The Brain not the Sole Organ of the Mind," it appears to be necessary that I should in the first place, as clearly as possible, express my ideas relative to the connection between the mind and the nervous system, and of the nature of that power which in its full development places man at the head of all other animals.

* Notwithstanding the earlier publication of this address at the time of its delivery, in one of the New York city papers, we think it every way worthy the place we have assigned it.

We have no evidence to show that the mind can exist independently of the nervous system. On the contrary, every fact in our possession bearing upon the question of their relation goes to prove that where there is no nervous system there is no mind, and that where there is injury or derangement of the nervous system, there is corresponding injury or derangement of the mind.

The nervous system consists of two essentially different tissues, which are distributed in varying proportions throughout the organism. The one of them, the ganglionic or gray tissue, is collected in masses in the brain, the spinal cord, and in the course of the ramifications of the great sympathetic nerve; the other, the white tissue, exists in much larger proportion, and is also found in the brain and spinal cord, of which it constitutes the larger quantity. Besides the sympathetic nerve, the nerves of sensation and of motion, and the compound nerves (which are both sensory and motor) consist entirely of white tissue. Examined microscopically, the gray matter is found to be composed of cells, while the white matter consists of fibres. As regards function, the difference is still greater, for the gray matter is the generator of nerve force, while the white simply serves as the medium by which the force is transmitted.

The brain is by far the largest mass of nerve substance contained in the body of any animal possessing a brain; indeed, it far exceeds in bulk and weight all the rest of the nervous system together. The researches of European observers give 49½ ounces as the weight of the average brain of the white inhabitants of Europe — the maximum, that of Cuvier, being 64⅛ ounces, and the minimum, consistent with a fair degree of intelligence, 34 ounces. Webster's brain (allowance being made for disease which existed) weighed 63¾ ounces, Dr. Abercrombie's 63 ounces, and Spurzheim's $55\frac{1}{16}$ ounces. The average of twenty-four American brains, accurately weighed by Dr. Ira Russell, was 52.06 ounces—the maximum 64 and the minimum 44.25 ounces. The same observer found the average full negro brain, as determined from 147 specimens, to be but 46.96 ounces.

The capacity of Daniel Webster's cranium was the largest

on record, being 122 cubic inches. That of the Teutonic family, including English, Germans and Americans, is 92 cubic inches. In the native African negro it is 83 cubic inches, and in the Australian and Hottentot but 75. The brain of the idiot seldom weighs over 23 ounces, and it is often much less than this. In one instance coming under my own observation, the weight of the entire brain was but 14½ ounces. Mr. Gore has related in the *Anthropological Review*, the particulars of a case of microcephaly in which the brain weighed but 10 ounces and 5 grains. The subject, a female, though forty-two years of age, had an intellect which is described as infantine. She could say a few words, such as "good" "child," "morning," with tolerable distinctness, but without connection or clear meaning, and was quite incapable of anything like conversation. Her habits were decent and cleanly, but she could not feed herself—at least with any degree of method or precision. She was fond of carrying and nursing a doll. In a case described in a subsequent number of the same journal, by Professor Marshall, the weight of the entire brain was but 8½ ounces. The subject was a boy twelve years of age. Nothing is said relative to the intelligence manifested.

Absolutely, the normal human brain is larger than that of any other animal except that of the elephant and the whale. *Relatively to the weight of the body*, it very greatly exceeds the proportion existing in either. Leuret found the mean proportional weight of the brain to the rest of the body to be in fishes as 1 to 5,668. The range in these animals is, however, very great. In the bass, I found it, as the result of eleven observations, to be as 1 to 523; in the eel, twenty-two observations, as 1 to 1,429; and in the gar-fish, nine observations, as 1 to 8,915.

In reptiles of different orders Leuret determined the average to be as 1 to 1,321. I found the proportion in frogs to be as 1 to 520; in lizards, as 1 to 180, and in the rattlesnake as 1 to 1,825. The brain of an alligator, over six feet in length, which I examined, weighed but a little over half an ounce.

Next in order come the birds, and here we find a very decided increase in the proportion. From many determinations made by Haller, Cuvier, Carus and himself, Leuret gives

the average as 1 to 212. In the tomtit he found it as 1 to 12; in the canary bird, as 1 to 14; in the pigeon, as 1 to 91; in the duck, as 1 to 241; in the chicken, as 1 to 377, and in the goose as 1 to 3,600. These are very great differences, and, as Leuret remarks, have no constant relation to the intelligence. It is worthy of notice that the brain is proportionally smaller in those birds which are domesticated, and which consequently do not have to make so severe a struggle for existence, than in the wild birds; and their brains, therefore, are more encumbered by fat. From determinations that I made, it was ascertained that the brain of the canary bird reared in the United States was in weight compared to that of the body as 1 to 10.5, and in the Arctic sparrow as 1 to 11. No observations on record show proportionally larger brains than these.

Among mammals we find a still greater increase in the weight of the brain as compared with that of the body. Leuret found it to range in the monkeys from as 1 to 22, 24, and 25; in the dolphin it was as 1 to 36; in the cat, as 1 to 94; in the rat, as 1 to 130; in the fox, as 1 to 205; in the dog, as 1 to 305; in the sheep, as 1 to 351; in the horse, as 1 to 700, and in the ox as 1 to 750. The mean for the class of mammals, exclusive of man, was as 1 to 186. My own observations accord very closely with those of Leuret. I found that in the prairie wolf the proportion between the brain and the body was as 1 to 220; in the wildcat as 1 to 158, and in the rat as 1 to 132.

If these figures teach anything at all, it is that there is no definite relation existing between the intelligence of animals and the absolute or relative size of the brain. It is true that taking the data collected by Leuret as the basis, there is a well-defined relation between the mental development and the brain, as regards the several classes of vertebrate animals; for in fishes, the lowest, the brain is but one 5,668th part of the body; in reptiles, the next highest, it is one 1,321st part; in birds, next in the ascending scale, it is one 212th part, and in mammals, the highest of all, one 186th part. There is, therefore, beginning with the lowest class, a regular ascent in the volume of the brain till it reaches the maximum in mammals.

But when we look at the relation as it exists between the different orders and genera of any one class, we cannot say

that there is any such variation in the degree of mental development as we should expect to find if the brain were the only source of the intelligence, and some members of the very lowest class have relatively larger brains than certain animals of the very highest. Thus the brain of the bass is to the body as 1 to 523, while in the horse it is but as 1 to 700, and in the ox as 1 to 750. If the relative size of the brain is to be taken as an indication of the degree of intelligence, we must regard the bass as a more intellectual animal than either the horse or the ox. The lizard has a brain which bears the high proportion to the body of 1 to 180. This is greater than that existing in the fox, the dog, the sheep, and several other mammals. The canary bird and the Arctic sparrow have brains proportionately larger than those of any other known animals, including man, and yet no one will contend that these animals stand at the top of the scale of mental development. Man, who certainly stands at the head of the class of mammals, and of all other animals, so far as mind is concerned, rarely has a brain more than one 50th the weight of the body, a proportion which is much greater in several other mammals, and is, as we have seen, exceeded by many of the smaller birds.

Even in absolute weight, independent of any relation to the rest of the body, the brain of man is not the largest, being exceeded by that of the elephant and the whale. But when we inquire into the matter of the absolute and relative quantity of gray nerve tissue, we find that in this respect man stands pre-eminent; and it is to this fact that he owes the great mental development which places him so far above all other living beings, for it is the gray tissue which originates mind—the white, as is well known, serving only for the transmission of impressions and impulses. Unless regard is paid to this point, we would certainly fall into serious error in determining the relation existing between the mind and the nervous system; but having it in view, the connection is at once clear and well-defined, there being no exception to the law that the mental development is in direct proportion to the amount of gray matter entering into the composition of the nervous system of any animal of any kind whatever.

But all the gray tissue of the nervous system is not confined

to the brain. A large proportion of it is found in the ganglia of the sympathetic and some other nerves, and an amount second only to that of the brain in quantity—and, indeed, in some animals larger—is present as an integral constituent of the spinal cord, and I propose to discuss on this occasion some of the more important questions connected with the qualities of the force evolved from this gray tissue of the cord, and to call attention to some of the phenomena attendant on its evolution.

By the term mind I understand a force developed by nervous action. It bears the same relation to gray nerve tissue that heat or electricity or light does to chemical or mechanical action. Why mind should result from the functionation of gray nerve tissue is no more a mystery than the fact that the mixing of water with sulphuric acid develops heat, or the rubbing of a piece of sealing wax with a piece of silk causes the evolution of electricity. All are equally beyond our understanding—all are equally ultimate facts in science, and speculations in regard to the rationale of all are equally vain and unprofitable.

All the manifestations of which the mind is capable in its fullest development are embraced in four groups: perception, the intellect, the emotions, and the will. Either one of these may be exercised independently of the others. Thus, an individual may have a perception without any intellectual, emotional, or volitional manifestation, and so the intellect, the emotions or the will may be brought into action without the necessary participation of each other. It is, however, clearly established that all mental processes of any kind have their origin in perception, and that an individual born without the ability to perceive, either from defects in the external organs of the senses or of the central ganglia, by which impressions on these organs are converted into perceptions, would be devoid of intellect, emotion and will—would be, in fact, lower in mental development than the most degraded types of animated beings.

Perception is the primary manifestation of mind, and is that part the office of which is to place the individual in relation with external objects. Thus an image is formed upon the retina, the optic nerve transmits the excitation to its ganglion, this at

once functionates, the force called perception is evolved, and the image is perceived. If the retina be sufficiently diseased, the image is not formed; if the optic nerve is in an abnormal condition, the excitation is not transmitted; if the ganglion is disordered, the perceptive force is not evolved. Therefore, in order that a true perception may be experienced, an organ of sense, a nerve and a mass of gray nerve tissue are necessary, and no other organs are required.

It is rarely the case that an individual perceives an impression made upon any one of the organs of the senses without a higher mental operation being performed. This is especially the case when the perception is of such a character as to be irritative. Thus, if an exceedingly bright light be allowed to impinge upon the retina, the brows are corrugated, and if it be still more intense, the eyelids are closed so as to shut it out altogether; if a very loud noise strikes upon the tympanum, the head is turned so as to prevent the undulations of the atmosphere reaching the ear in full force; if the skin be irritated, the part is, if possible, drawn away, and if the irritation be so great as to excite pain, the whole body is thrown into contortions and efforts are made to escape. Some of these movements appear to be involuntary, and even to be performed in direct opposition to the will, and then they are said to be reflex—that is, that they are the result of the conversion of a sensation into a motor impulse without the accompanying action of any ganglion, the action of which is the evolution of volitional force.

Now it is very true that some of the actions in question are apparently altogether involuntary, and are thus true reflex movements, and it is no difficult matter to separate them from those other which are clearly volitional, determinate, and performed with a definite purpose in view. If, for instance, an irritative substance be applied to the interior of the nostril, the action which we call sneezing is produced. This consists of a spasmodic contraction of certain muscles by which the air in the lungs is forcibly expelled through the nostrils. It is automatic and preservative in character, the object being to get rid of the offending substance. It is always performed in the same way, the muscles brought into action are always the same, and

it is spasmodic, sudden, and without deliberation or judgment, so far as we can determine from our own consciousness. Again, if the soles of the feet are tickled, they are drawn away, although it is possible for the impulse to remove them to be restrained by the exercise of the will, and, indeed, some individuals can prevent sneezing by strong volitional power evolved from the higher ganglia of the brain. But let us suppose the case of a man with a disease of the upper part of the spinal cord of such a character as to prevent its conveying volitional impulses from the brain to the muscles of the lower limbs; now let the soles of the feet be tickled, and we will find that they are drawn away, and generally with very much more force than when the brain is allowed to act. Such a movement is probably one of a true reflex character; it is spasmodic and indeterminate, being more extensive than is necessary. But let us go still further in our suppositions, and imagine that in such a case the mere drawing away of the foot was not sufficient to escape the irritation, and that the individual deliberately lifted up the other foot in the attempt to remove the offending object, and that this action not proving adequate, he made two or three leaps in order to escape. What would we call these movements? Would they not be evidence of perception and will? Would they not be movements performed with a definite purpose — the very best possible under the circumstances — to escape from the irritation even though the brain were unconscious of them? It must be remembered that consciousness is not the necessary accompaniment of volition, as we shall presently see from examples I shall adduce; and this being the case, I cannot avoid the conclusion that actions performed under the circumstances I have stated, would be based upon perception and done through the power of volition.

Warm-blooded animals are for many reasons not suitable subjects for experiments such as are required in the study of the phenomena under consideration, but in some of the lower animals, as the frog, for instance, we find those conditions present which fit them for such investigations. Thus, if the entire brain be removed from a frog, the animal will continue to perform those functions which are immediately connected with the maintenance of life. The heart beats, the stomach

digests, and the glands of the body continue to elaborate the several secretions proper to them. These actions are immediately due to the sympathetic system, though they soon cease if the spinal cord be materially injured. But, in addition, still more striking movements are effected, movements which are well calculated to excite astonishment in those who see them for the first time, and who have embraced the idea that all intelligence resides in the brain. For instance, if in such a frog the web between the toes be pinched, the limb is immediately withdrawn; if the shoulder be scratched with a needle, the hind foot of the same side is raised to remove the instrument; if the animal is held up by one leg, it struggles; if placed on its back—a position to which frogs have a great antipathy—it immediately turns over on its belly; if one foot be held firmly with a pair of forceps, the frog endeavors to draw it away; if unsuccessful, it places the other foot against the instrument and pushes firmly in the effort to remove it; still not succeeding, it writhes the body from side to side, and makes a movement forward.

All these and even more complicated motions are performed by the decapitated alligator, and in fact may be witnessed to some extent in all animals. I have repeatedly seen the headless body of the rattlesnake coil itself into a threatening attitude, and, when irritated, strike its bleeding trunk against the offending body. Upon one occasion, a teamster on the western plains had decapitated one of these reptiles with his whip, and while bending down to examine it more carefully, was struck by it full in the forehead; so powerful was the shock to his nervous system that he fainted and remained insensible for several minutes. According to Maine de Biran, Perrault reports that a viper whose head had been cut off moved determinedly toward its hole in the wall. This subject has been well studied by Dr. Dowler, of New Orleans, by Pfluger,* Paton,† Onimus,‡ and several others. I have

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* *Die Sensorischen Functionen der Rueckenmarks der Wirbelthiere, u. s. w.* Berlin, 1853.

† *On the Perceptive Power of the Spinal Cord, as manifested by Experiments on Cold-blooded Animals.*

‡ *Journal d' Anatomie et de Physiologie*, October, 1871.

performed a great many experiments and made numerous observations relative to the matter, and have for a number of years taught in my courses on diseases of the mind and nervous system the doctrine now set forth, that wherever there is gray nerve tissue in action, there there is mind also. To the details of some of these experiments, I beg to invite the attention of the Society, merely premising that I have quite recently gone over the ground with great care, verifying with as much exactness as possible the results obtained by others and by myself, and extending the scope of the experiments in several important particulars.

Experiment I.—I removed the brain of a large frog, and then waiting a few minutes for the animal to recover from the shock of the operation, proceeded as follows: I pinched the left hind foot with a pair of forceps, and the limb was at once withdrawn; I pinched a little harder and the animal struggled vigorously to escape, and succeeding, made several leaps, each of two or three feet in length. I then touched the right side of the abdomen with a glass rod on which was a drop of vinegar. The right hind foot was at once carried to the exact spot I had touched, and was rubbed energetically against the skin. The left side was treated similarly, and the rod being held in contact with the skin, it was pushed away by the left hind foot. The skin over the left shoulder was then seized with the forceps and tightly held; efforts were made to remove the instrument with the left hind foot, then with the left fore foot, and these not succeeding, the whole body of the animal was violently agitated, and through the struggling the hold of the forceps was broken and the frog gave two leaps. Laid upon its back, it immediately resumed the ordinary position on its belly with its hind legs drawn up. I then held the glass rod with a drop of vinegar against the right dorsal region. The frog tried to push the instrument away with its right hind foot. I cut off this foot, and it then made similar efforts with the left hind foot. These not being effectual, it made a leap of about a foot, and then scratched the irritated spot with the left hind foot.

Experiment II.—I removed the brain from a frog, and after waiting as before for the immediate effects of the operation to

disappear, placed the animal in a tub of water. It immediately began to swim. I held my hand so that the animal's head would come in contact with it, and prevent further progress. Continued efforts to swim were made for a few seconds and then ceased. Removing my hand, the animal again swam.

Of these movements Vulpian says, that when the frog is placed in water an excitation is produced over the entire surface of the body in contact with the water; this excitation provokes the mechanism of swimming, and this mechanism ceases to act as soon as the cause of the excitation has disappeared, by the removal of the frog from the water. If this were a true explanation, the movements of swimming would certainly be continued, notwithstanding the interposition of an obstacle; but, as we have seen, they are arrested. Onimus shows very conclusively, and I have verified his experiment, that Vulpian's explanation is not correct; for, as he declares, with frogs without brains placed in water, and from which the skin has been entirely removed, the movements of swimming are continued when they are placed again in water, which proves that the excitation of the cutaneous surface is not the true cause of these movements.

Now, what do such experiments show? If they do not prove that the spinal cord has the power of perception and of volition, what do they prove? What more could the animal possibly do to escape the inconvenience to which it is subjected by having an irritation applied to its body? It must be remembered that it has but one sense — that of touch — left, and that one-half or more of all the gray nerve tissue of its organism has been removed. It will not suffice to say, with Dr. Maudsley,* that they are no more evidence of consciousness and will than is the fact that in the double decomposition of a chemical salt one acid chooses voluntarily the other base; for in the first place the acid and the base are not organized and living substances, and in the next place they always act in precisely the same way under similar circumstances, which is not the case in the movements of the frog deprived of its brain. It is true that there is a general similarity of actions,

* *Body and Mind*, second edition, London, 1873, p. 9.

but so there is when the brain has not been removed, and so there is also in the higher animals, man included, when the circumstances determining certain actions are identical. And this is so well-known a fact that we can predict with exactness what movements will be performed under known conditions, not only as regards the lower animals, but man himself. Dr. Maudsley admits that the actions in question are for a definite end, and have the semblance of pre-designing consciousness and will, but he then says that they may be quite unconscious and automatic. But he forgets that in all our relations with our fellow creatures the only evidence we have of their consciousness and volitional power is derived from our knowledge of their actions. No one can say with absolute certainty that any other person is performing a conscious and voluntary act. That is a matter which is only known to the individual himself; and hence, however conscious the frogs submitted to such experiments may be, we have no means of ascertaining the fact except by the careful study of the psychical and physical phenomena manifested. We interrogate them and the answers are perfectly logical and definite; no less so, in fact, than they would have been had the brain not been removed.

But there are many other facts which go to show that the spinal cord is something more than a nerve centre for reflex actions and a conductor of impressions to and from the brain. Paton, in a salamander, divided the vertebræ and spinal cord immediately below the brachial plexus, so that the anterior extremities were still in nervous communication with the brain through the upper part of the cord, while the posterior extremities were cut off from it, and only received nervous influence from the lower part of the cord. After allowing a few minutes to elapse, the following phenomena were observed:

"The animal raised itself upon its fore legs and began to move forward, but did not drag its hind feet like an animal that had suffered paralysis, but supported its body on them as on its fore legs, and exerted them distinctly in the act of locomotion. I could observe no difference between these movements and those which it performed before the division of the cord, except that it now walked with less power and energy. I allowed the animal to remain at rest for a short time, and

then slightly touched with the point of a needle the integuments of the right dorsal region, and it raised up its right hind foot and passed its toes across the part. On irritating the integuments of the left side of the abdomen, it raised up its left hind foot again and again to the part. After a short interval, I touched with the point of a needle the upper portion of the left dorsal region immediately below the division of the cord, and it raised up its left hind foot and passed its toes distinctly over the part. I continued the irritation, and the animal repeated the movement, raising up its left hind foot and passed its toes over the part."

This experiment was repeated with some variation of the details, but with the result of obtaining analogous movements. Thus, it was clearly proven that the posterior extremities of the animal were capable of being brought into harmonious action with the anterior, though the former were separated from all nervous relations with the brain, and as a consequence, that the spinal cord is a centre for perception and volition.

Dr. Carpenter* says of frogs, that "if the spinal cord be cut across without the removal of the brain, the lower limbs may be excited to movement by an appropriate stimulus, though the animal has clearly no power over them, whilst the upper remain under its control as completely as before;" and from this fact he deduces the argument that the spinal cord is not a centre of voluntary motion. But Paton's experiments with the salamander show that, however true this may be of frogs, it is not true as regards all other animals, and hence, Dr. Carpenter's reasoning is of no force.

Dr. Carpenter then goes on to say that it is scarcely conceivable that sensations should be felt and volition exercised through the instrumentality of that portion of the cord which remains connected with the posterior extremities, but which is cut off from the brain; for if this were so, he alleges, there must be two centres of sensation and will in the same animal, the attributes of the brain not being affected, and by dividing the spinal cord into two or more segments we might thus create in the body of one animal two or more such independent

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* *Principles of Mental Physiology*, London, 1874, p. 69.

centres in addition to that which still holds its proper place within the head. This inference is very correct, but the condition which Dr. Carpenter assumes to be impossible actually exists, not only in the salamander, as shown by Dr. Paton, but in other animals, especially those belonging to the class articulata.

Thus, in the centipede there is a closely-united pair of ganglia for each segment of the animal's body, and at the anterior extremity of the body a larger pair, which may stand for the brain. Now, as is well known, and as Dr. Carpenter himself says, "if the head of the centipede be cut off whilst it is in motion the body will continue to move onwards by the action of the legs; and the same will take place in the separate parts, if the body be divided into several distinct portions. After these actions have come to an end, they may be excited again by irritating any part of the nerve centres or the cut extremity of the nervous cord. The body is moved forward by the regular and successive action of the legs, as in the natural state; but its movements are always forward, never backwards, and are only diverted to one side when the forward movement is checked by an interposed obstacle. If this obstacle be not more than half the height of the animal, the body mounts over the obstruction and continues its course." It will not suffice to say, with Dr. Carpenter, that, though these movements *seem* to indicate consciousness, they do not in reality, and that they are merely manifestations of reflex excitability. Not only do they show perception and volition, but they establish the very fact which, as we have just seen, Dr. Carpenter denies—that there are several centres of sensation and of volition in some animals, if not in all.

In birds, the phenomena observed after removal of the brain go to show that perception and will are equally, as in cold-blooded animals, seated in the spinal cord. A pigeon turns its head in accordance with the motion given to a lighted candle held before its eyes; it smooths its feathers with its bill when they are ruffled; it places its head under its wing when it sleeps; it opens its eyes when a loud noise is made close to its head. Onimus removed the brain from young ducks hatched and brought up by a chicken. These ducks had never been

in the water, yet when placed in a basin they immediately began to swim. Their motions in swimming were as regular as in other ducks which had lived in the water. This series of experiments shows that even the inborn instinct of animals is not solely resident in the brain.

Now, when we come to man, and observe the experiments which are constantly being made for us, both in health and disease, we cannot avoid placing the spinal cord much higher as a nerve centre than it is usually placed by physiologists.

In anencephalic monsters, or those born without a brain, we have interesting examples of the fact that the spinal cord is possessed of perception and volitional power. Syme* describes one of these beings which lived for six months. Though very feeble, it had the faculty of sucking, and the several functions of the body appeared to be well performed. Its eyes clearly perceived the light, and during the night it cried if the candle was allowed to go out. After death the cranium was opened, and there was found to be an entire absence of the cerebrum, the place of which was occupied by a quantity of serous fluid contained in the arachnoid. The cerebellum and pons varolii were present. Panizza,† of Pavia, reports the case of a male infant which lived eighteen hours. Respiration was established, but the child did not cry. Nevertheless, it was not insensible. Light impressed the eyes, for the pupils acted. A bitter juice put into the mouth was immediately rejected. Loud noises caused movements of the body. On post-mortem examination, there was found no vestige of either cerebrum or cerebellum, but the medulla oblongata and pons varolii existed. There were no olfactory nerves; the optic nerves were atrophied, and the third and fourth pairs were wanting; all the other cranial nerves were present.

Ollivier d'Angers‡ describes a monster of the female sex which lived twenty hours. It cried, and could suck and swallow. There was no brain, but the spinal cord and medulla oblongata were well developed.

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* *Edinburgh Medical and Surgical Journal*, vol. XXIV., p. 295.

† Cited by Gintrac, *Maladies de l' Appareil Nerveux*, t. I., 51.

‡ *Maladies de la Moelle épinière*, t. I., p. 179.

Saviard† relates the particulars of a case in which there were no cerebrum, cerebellum, or any other intracranial ganglion. The spinal cord began as a little red tumor on a level with the foramen magnum. Yet this being, opened and shut its eyes, cried, sucked, and even ate broth. It lived four days.

Mr. Lawrence‡ has published the details of a very interesting case in which there was no brain. But the excito-motory functions were well performed. The child moved briskly and gave evidence of feeling pain. Its breathing and temperature were natural, it discharged urine and fæces, and took food. Movements such as these do not afford evidence of a very high degree of intellect, but they are precisely such as are performed by all new-born infants possessed of brains. If they are not indicative of the existence of mind, we must deny this force to all human beings on their entrance into the world.

But we are not obliged to rest on the phenomena afforded by anencephalic monsters for all the evidence that the spinal cord of man is a centre of perception and volition. We have only to observe the manifestations of its action which are of daily occurrence in our own persons. And in bringing them to your notice I shall quote from a little work on *Sleep and its Derangements*, which I wrote a few years ago.

"If an individual engaged in reading a book allows his mind to be diverted to some other subject than that of which he is reading, he continues to see the words, which, however, make no impression on his brain, and he turns over the leaf whenever he reaches the bottom of the page, with as much regularity as though he comprehended every word he had read. He suddenly, perhaps, brings back his mind to the subject of his book, and then he finds that he has perused several pages without having received the slightest idea of their contents.

"Again, when, for instance, we are walking in the street and thinking of some engrossing circumstance. We turn the right corner and find ourselves where we intended to go, without being able to recall any of the events connected with the act of getting there."

† Cited by Gintrac, op. cit., p. 46.

‡ Davey on *The Ganglionic Nervous System*, London, 1858, p. 92.

In such instances as these — and many others might be adduced—the brain has been so occupied with a train of thought that it has taken no cognizance or superintendence of the actions of the body. The spinal cord has received the several sensorial impressions and has furnished the nervous force necessary to the performance of the various physical acts concerned in turning over the leaves, avoiding obstacles, taking the right route and stopping in front of the right door.

All cases of what are called "absence of mind" belong to the same category. Here the brain is completely pre-occupied with a subject of absorbing interest, and does not take cognizance of the events which are taking place around. An individual, for instance, is engaged in solving an abstruse mathematical problem. The whole power of the brain is taken up in this labor, and is not diverted by circumstances of minor importance. Whatever actions these circumstances may require are performed through the force originating in the spinal cord.

The phenomena of reverie are similar in some respects to those of somnambulism, to which attention will presently be directed. In this condition the mind pursues a train of reasoning often of the most fanciful character, but yet so abstract and intense that, though actions may be performed by the body, they have no relation with the current of thought, but are essentially automatic, and made in obedience to sensorial impressions which are not perceived by the brain. Thus, a person in a state of reverie will answer questions, obey commands involving a good deal of muscular action, and perform other complex acts, without disturbing the connection of his ideas. When the state of mental occupation has disappeared there is no recollection of the acts which may have been performed. Memory resides in the brain, and can only take cognizance of those mental acts which spring from the brain, or of impressions which are made directly on the encephalon.

In the case of a person performing on the piano and at the same time carrying on a conversation, we have a most striking instance of the diverse though harmonious action of the brain and spinal cord. Here the mind is engaged with ideas, and the spinal cord directs the manipulations necessary to the proper rendering of the musical composition. A person who

is not proficient in the use of this instrument cannot at the same time play and converse with ease, because the spinal cord has not yet acquired a sufficient degree of automatism. Darwin gives a very striking example of the independent action of the brain and spinal cord. A young lady was playing on the piano a very difficult musical composition, which she performed with great skill and care, though she was observed to be agitated and pre-occupied. When she had finished she burst into tears. She had been intently watching the death struggles of a favorite bird. Though the brain was thus absorbed, the spinal cord had not been diverted from the office of carrying on the muscular and automatic actions required by her musical performance.

In somnambulism the brain is asleep, and this quiescent state of the organ is often accompanied, in nervous and excitable persons, by an exalted condition of the spinal cord, and then we have the highest order of somnambulic manifestations, such as walking and the performance of complex and apparently systematic movements. If the sleep of the brain be somewhat less profound, and the spinal cord less excitable, the somnambulic manifestations do not extend beyond sleep-talking; a still less degree of cerebral inaction and of spinal irritability produces simply a restless sleep and a little muttering; and when the sleep is perfectly natural, and the nervous system of the individual well balanced, the movements do not extend beyond changing the position of the head and limbs and turning over in bed.

The phenomena of catalepsy, trance and ecstasy are also indicative of an independent action of the spinal cord, inasmuch as the power of the brain is not exercised over the body, but is either quiescent or engrossed with subjects which have made a strong impression upon it. Some of the manifestations of mind shown under such conditions are exceedingly interesting, and are altogether outside of the domain of cerebral consciousness.

And now I must bring this address to a close, though I have by no means exhausted all the facts and arguments which could be brought forward. I by no means contend that the spinal cord—to say nothing of the sympathetic system—is in the

normal condition of the animal body, as important a centre of mental influence as is the brain. The latter organ predominates. The very highest attributes of the mind come from it, and the cord is subordinate when the brain is capable of acting. But it seems to me illogical to deny mental power to the spinal cord after a consideration of such experiments and other facts as I have brought forward, and hence we are, I think, justified in concluding:

1st. That of the mental faculties, perception and volition are seated in the spinal cord, as well as in the cerebral ganglia.

2d. That the cord is not probably capable of *originating* mental influence independently of sensorial impressions — a condition of the brain also, till it has accumulated facts through the operation of the senses.

3d. That as memory is not an attribute of the mental influence evolved by the spinal cord, it requires, unlike the brain, a new impression, in order that mental force may be produced.